EFFECTIVENESS OF INTEGRATED ERGONOMICS INTERVENTION APPROACH IN REDUCING MUSCULOSKELETAL DISORDERS AMONG OIL PALM HARVESTERS IN JOHOR BAHRU, MALAYSIA

NG YEE GUAN

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By

NG YEE GUAN

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirements for the Degree of Doctor of Philosophy

November, 2014
DEDICATION

Thank Allah s.w.t., the Almighty, the All-knowing who has given me the time, blessing, assistance, guidance and tenacity to finish this dissertation. I would like to dedicate this work to my family and many friends. A special feeling of gratitude to my loving parents, whose words of encouragement and unwavering supports who have never left my side and are very special.

I also dedicate this dissertation to my friends and colleagues who have supported me throughout the process. I will always appreciate all they have done, especially my supervisors for guiding me, developing my skills, all those who spent many hours of assisting me in facing hardship and difficulties. Those who were around me to remind me, helping and easing the burden.

Also special thanks to the organizations involved in this research, those who’s acquainted with me in the course of this dissertation work, thank you all for permissions, the kind company, assistance and help, no matter how big or small you have all provided and granted.

May Allah s.w.t. bless us all.
Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Doctor of Philosophy

EFFECTIVENESS OF INTEGRATED ERGONOMICS INTERVENTION APPROACH IN REDUCING MUSCULOSKELETAL DISORDERS AMONG OIL PALM HARVESTERS IN JOHOR BAHRU, MALAYSIA

By

NG YEE GUAN

November, 2014

Chairman:  Associate Professor Shamsul Bahri Mohd Tamrin, PhD

Faculty:  Medicine and Health Sciences

Objective:  This study intend to determine the effectiveness of an integrated ergonomics interventions approach, highly promoted by International Labour Organization to resolve ergonomics issues specifically among oil palm harvesters and to improve Occupational Safety and Health aspects of the workplace during early harvesting stage in oil palm plantation.

Methodology:  Divided into two phases, the first phase of the cross-sectional design involved 446 male respondents working as harvesters (263 fresh fruit bunch (FFB) cutters; 183 FFB collectors). Questionnaires were used to collect information on socio-demographic data, occupational history, social lifestyle, prevalence of musculoskeletal disorders (MSDs) and productivities data. Video recording was used to assist postural assessment of harvesters using Ovako Working Posture Analysis System (OWAS). An intervention package based on Participatory Action Oriented Training (PAOT) approach were subsequently designed and implemented in the second phase of the study. The intervention program features video, interactive lectures, games and action checklist. Two instruments were used to assess the effectiveness; knowledge, attitude and practice as well as body symptom questionnaire. Besides that, qualitative observation were also used to determine physical improvement or change from the intervention program.

Results:  Ergonomics risk factors particularly awkward postures, repetitive motion and forceful exertion were predominant among harvesters (both FFB cutters and FFB collectors) in oil palm plantation. Evidently, the 12 months and 7 days prevalence of MSDs at any body parts were 86% and 45% for respective duration. Lower back pain was the most commonly self-reported symptoms followed by knee neck and shoulder
for both FFB cutters and FFB collectors. Significant risk factors of MSDs among the harvesters such as education level, body mass index, awkward postures, daily working and resting hours, working overtime and hobby (fishing) explain some but not all of the risk factors. Significant productivity loss were also observed among harvesters with acute MSDs where they were almost 3 times likely to be still working (presenteeism, OR=2.87; CI=1.34, 6.14) but produce only half as much as their healthy (without MSDs) colleagues (daily productivity, OR=2.09, CI=1.02, 4.29). The ergonomics intervention, PAOT approach were successfully implemented despite severely unanticipated and unavoidable limitations. The post-intervention assessment indicates that although the total knowledge, attitude and practices (KAP) score increased within IG (Friedman test, $\chi^2=16.831$, $p<0.01$), there were however no significant difference as compared to CG. In terms of MSDs, the post-intervention assessment were not effective to reduce the prevalence of MSDs within the intervention group (IG) as well as between control group (CG).

Conclusion: Findings in this study indicates that effective intervention strategy among oil palm harvesters during early harvesting stage is crucially required considering the health effect in terms of MSDs and the productivity loss. Despite being reported effective in various other agricultural application, the application of PAOT approach did not indicate effectiveness on multinational corporate oil palm plantation potentially attributable to the severe limitation of this study. Thus, it is recommended that future research work consider the limitations as reported in this study besides further exploration of other ergonomics risk factors and biomechanics of harvesting tasks using prospective research design.

(Keywords: oil palm plantation, harvesters, ergonomics, MSDs, intervention, PAOT)
Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Doktor Falsafah

KEBERKESANAN INTERVENSI ERGONOMIK DALAM MENGURANGKAN GANGGUAN OTOT-RANGKA DI KALANGAN PENUAI KELAPA SAWIT DI JOHOR BAHRU, MALAYSIA

Oleh

NG YEE GUAN

November, 2014

Pengerusi: Profesor Madya Shamsul Bahri Mohd Tamrin, PhD

Fakulti: Perubatan dan Sains Kesihatan

Objektif: Kajian ini bertujuan untuk menentukan keberkesanan pendekatan intervensi ergonomik bersepadu, sangat digalakkan oleh Pertubuhan Buruh Antarabangsa untuk menyelesaikan isu-isu ergonomik khususnya di kalangan penuai kelapa sawit dan untuk meningkatkan aspek Kesihatan tempat kerja Keselamatan di ladang sawit pada peringkat penuaan awal di ladang kelapa sawit.


Keputusan: Faktor-faktor risiko ergonomik terutamanya postur janggal, gerakan berulang-ulang dan kerahan tenaga secara paksa adalah ketara di kalangan penuai (kedua-dua pemotong BTS dan pengumpul BTS) di ladang kelapa sawit. Prevalens MSDs bagi 12 bulan dan 7 hari di mana-mana bahagian badan adalah sebanyak 86% dan 45% masing-masing. Sakit belakang adalah gejala yang paling tinggi dilaporkan diikuti oleh leher, lutut dan bahu bagi kedua-dua pemotong BTS dan pengumpul BTS. Faktor-faktor risiko utama MSDs bagi penuai adalah tahap pendidikan, indeks jisim badan, postur janggal, jumlah jam bekerja dan berehat harian, bekerja lebih masa dan
hobi (memancing) menjelaskan beberapa tetapi tidak kesemua faktor-faktor risiko MSDs. Kehilangan produktiviti yang ketara telah juga diperhatikan di kalangan penuai yang mengalami MSDs akut di mana mereka hampir 3 kali mungkin masih bekerja (presenteeism, OR=2.87; CI=1.34,6.14) tetapi hasil tuaian hanya separuh daripada kuantiti rakan-rakan sekerja mereka yang sihat (tanpa MSDs) (produktiviti harian, OR=2.09, CI=1.2, 4.29). Sungguhpun intervensi ergonomik menggunakan pendekatan PAOT telah dilaksanakan dengan jayanya tetapi terdapat pelbagai batasan dan limitasi yang telah memberi kesan kepada hasil intervensi tersebut. Penilaian selepas intervensi menunjukkan bahawa tiada perbezaan signifikan yang dilihat bagi skor pengetahuan, sikap dan amalan (KAP) dan juga prevalens MSDs. Walaupun skor KAP meningkat di kalangan kumpulan intervensi (IG) (ujian Friedman, $\chi^2 = 16.831$, $p <0.01$), tiada perbezaan ketara yg dapat dilihat bagi prevalens MSDs di dalam kumpulan yang sama.

Kesimpulan: Penemuan dalam kajian ini menunjukkan bahawa strategi intervensi yang berkesan di kalangan penuai kelapa sawit pada peringkat penuaan awal amat diperlukan berikutan kesan kesihatan dari segi MSDs dan kehilangan produktiviti. Walaupun dilaporkan berkesan dalam pelbagai aplikasi pertanian yang lain, keberkesanan pendekatan PAOT terutamanya di ladang kelapa sawit korporat multinasional berupaya disisihkan oleh sistem pengurusan berdasarkan hierarki dan konflik organisasi. Maka, adalah disyorkan bahawa kerja-kerja penyelidikan masa depan mengambil kira faktor-faktor risiko ergonomik lain yang tidak diterokai di dalam kajian ini termasuk kajian biomekanik dalam menggunakan reka bentuk kajian penyelidikan prospektif.

(Kata kunci: kelapa sawit, penuai, ergonomik, MSDs, intervensi, PAOT)
This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Doctor of Philosophy. The members of the Supervisory Committee were as follows:

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<td>IEA</td>
<td>International Ergonomics Association</td>
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<td>FAO</td>
<td>Food and Agriculture Organization</td>
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<td>PEMANDU</td>
<td>Performance Management &amp; Delivery Unit, a unit under Prime Minister Department of Malaysia</td>
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<td>MVO</td>
<td>Margarine, vetten en Oliën, a Netherland-based organization in the oil and fat business</td>
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<tr>
<td>UNDP</td>
<td>United Nations Development Programme</td>
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<tr>
<td>3P</td>
<td>Profit (Economics), People (Social) and Planet (Environment); the three elements of sustainability</td>
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<tr>
<td>CIA</td>
<td>Central Intelligence Agency, United States of America</td>
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<td>EPP</td>
<td>Entry Point Projects under the Economic Transformation Programme to spur growth of the Malaysia National Key Economic Areas</td>
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<td>NKEA</td>
<td>National Key Economic Area is the initiative of Malaysia government to drive potential economic activities which will contribute economic growth in Malaysia</td>
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<td>R &amp; D</td>
<td>Research and Development</td>
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<td>GNI</td>
<td>Gross National Income</td>
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<td>ETP</td>
<td>Economic Transformation Programme is an initiative by the Malaysian government to turn Malaysia into a high income economy by the year of 2020</td>
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<td>MSDs</td>
<td>Musculoskeletal disorders</td>
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<td>PAOT</td>
<td>Participatory Action-Oriented Training</td>
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<td>ILO</td>
<td>International Labour Organization</td>
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<td>FFB</td>
<td>Fresh Fruit Bunch</td>
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<td>BMI</td>
<td>Body Mass Index</td>
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<td>RSIs</td>
<td>Repetitive strain injuries</td>
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<td>CTDs</td>
<td>Cumulative trauma disorders</td>
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<td>Occupational overuse syndromes</td>
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<td>OCDs</td>
<td>Occupational Cervicobrachial Disorders</td>
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<td>NMQ</td>
<td>NORDIC Musculoskeletal Questionnaires</td>
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<td>OWAS</td>
<td>Ovako Working Posture Assessment System</td>
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<td>CDC</td>
<td>Center for Disease Control and Prevention</td>
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<td>KAP</td>
<td>Knowledge, attitude and practices</td>
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<td>SAFEWORK</td>
<td>Safety and Health at Work and the Environment</td>
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<td>OSH</td>
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<td>OSHE</td>
<td>Occupational Safety, Health and Ergonomics</td>
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<td>OPPs</td>
<td>Oil Palm Plantations</td>
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<td>MPOC</td>
<td>Malaysian Palm Oil Council</td>
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<td>WHO</td>
<td>World Health Organization</td>
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<td>NRC</td>
<td>National Research Council</td>
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<tr>
<td>IOM</td>
<td>Institute of Medicine</td>
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<td>US OSHA</td>
<td>United States Occupational Safety and Health Administration</td>
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<td>NIOSH</td>
<td>The National Institute for Occupational Safety and Health</td>
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<td>REBA</td>
<td>Rapid Entire Body Assessment</td>
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<td>QEC</td>
<td>Quick Exposure Checklist</td>
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<td>PAR</td>
<td>Participatory action research</td>
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<td>WISE</td>
<td>Work Improvements in Small Enterprises</td>
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<td>WIND</td>
<td>Work Improvement in Neighbourhood Development</td>
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<tr>
<td>FELDA</td>
<td>Federal Land Development Agency</td>
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<td>FELCRA</td>
<td>Federal Land Consolidation and Rehabilitation Authority</td>
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<td>UNEP</td>
<td>United Nations Environment Programme</td>
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<td>MPOB</td>
<td>Malaysia Palm Oil Board</td>
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<tr>
<td>FIOH</td>
<td>Finland and the Finnish Institute for Occupational Health</td>
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<td>IG</td>
<td>Intervention Group</td>
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CG  -  Control Group
RHEF  -  Rural Health Education Foundation
NWCHPC  -  Northwest Center for Public Health Practice
BSS  -  Body parts symptoms survey
ICC  -  Intraclass Correlation Coefficients
CHAPTER 1
INTRODUCTION

This chapter provides a brief introduction to the background of this research with an outline of the problem faced by the oil palm industry. Subsequently, the necessity of this research is being justified, followed by the objectives and the corresponding hypothesis. The conceptual framework of this research is also being presented while the conceptual and operational definition of some key terminology used in this research is also outlined.

1.1 Research Background

Used inter-exchangeable with the term Human Factor, ‘Ergonomics’ refers to an interdisciplinary sciences of physiology, psychology, anthropometry, biomechanics and various aspects of engineering in attempt of adapting human in terms of their physiology capacity to the work tasks and environment (Grandjean, 1980).

In a much contemporary definition (Hancock, 1997), this scientific study of relationship is a branch of science which seeks to turn human-machine interaction from antagonism into human-machine synergy. In simple term, ergonomics emphasize in fitting tasks and its environment to the workers with the purpose of bettering the human condition (Hancock and Diaz, 2002).

The most recent definition of ergonomics by International Ergonomic Association (IEA) broadly focuses on human–system interface design, inclusive of micro- and/or macro-systems are as follow:

Ergonomics (or Human Factors) is the scientific discipline concerned with the understanding of interactions among humans and other elements of a system, and the profession that applies theory, principles, data, and methods to design in order to optimize human well-being and overall systems performance (IEA, 2011).

Regardless of discipline or field, the ultimate aim of ergonomics is to improve human health, safety and performances through the sound application of people and workplace principles (Kohn, 1998) corresponding to the long history of occupational accidents, injuries, disorders and diseases attributable to the human-machine interaction or workplace design (EU-OSHA, 2011).

Ergonomics in agricultural industry has long been recognized for optimization of productivities in various agricultural settings where human labor is concerned (O’Neill and Rogan, 1993; Jafry and O’Neill, 2000; O’Neill, 2005). Various improvements of health and safety of farm workers as well as their quality of life socially and economically has been demonstrated to further reduce healthcare bill and compensation as a whole (Lundqvist and Gustafsson, 1992; Niu, 2010).

As with other agricultural sectors, the flourishing oil palm industry in Malaysia relies heavily on the production of the oil palm seeds from oil palm plantation. The palm oil
industry is currently the fourth largest contributors of Malaysia economy accounting of RM53 billion in gross national income (GNI) in 2009. As the global population continue to expand, the world food and energy consumption has increases accordingly. Changes in eating habits and increases in global food demand require that the food productions to be intensified to keep up with the already shortage in global food supply and cultivable land (Seegräf et al., 2010; Nellemann, et al., 2009; FAO, 2009).

Additionally, the fast depleting fossil fuel energy reserves has also led the search for a viable substitute source of energy to food as biofuel (Atabanii, et al., 2012). Eventually, palm oil has emerged as the most productive oil crop with value chain spanning from upstream plantation to downstream processing industrial activities (Thoenes, 2006; Sheil et al., 2009; PEMANDU, 2010; MVO, 2012).

While it has been suggested that palm oil may indeed be the solution towards uprising food and energy consumption and demand (FAO, 2002; Corley, 2005; UNDP, 2007; MVO, 2012), the industry has also been associated with social development in uplifting of poverty through employment in various stream of value chain as well as infrastructure development (Basiron, 2007; Cheng, 2010; Rist, Levang, and Feintrenie, 2010; Seegräf et al., 2010).

In recent advancement, the sustainability of the palm oil industry has gained much attention from various international stakeholders; both governmental and non-governmental organization. Particularly, the sustainable plantation practices addressing the 3P – profit (economics), people (social) and planet (environment) has been highlighted (Figure 1.1) following rapid expansion of the palm oil industry in various aspects (FAO, 2002; Corley, 2005; Hashim and Yuen, 2007; Cheng, 2010; Henriksson, 2012).

As of the year 2009, the Malaysia palm oil industry accounts for 71% (4.7 million hectares) of the 6.6 million hectares Malaysia national agricultural land bank for oil palm plantations in the upstream activities in additional of possessing 416 mills, 43 crushers, 51 refineries, 18 oleochemical plants and 25 biodiesel plants for the downstream processes – Figure 1.2 (PEMANDU, 2010).

With the Malaysia Economic Transformation Programme (ETP) launched on 2010, palm oil industry has been highlighted as one of the key sector towards national economic development. The mechanism through which the goal of becoming high income and developed nation by 2020 will be fostered by various concrete Entry Point Projects (EPP).

Various action strategies through the National Key Economic Area (NKEA) (Figure 1.3) were outlined in the goal of becoming developed nation by 2020 (PEMANDU, 2010). This following the fact that the realization that palm oil industry is still heavily skewed towards upstream activities albeit spans of value chain from upstream plantation to downstream processing (PEMANDU, 2010).

Although the upstream oil palm plantation activities is generally considered as agricultural subsectors, the ETP has extracted the palm oil industry as a standalone portfolio of the national key economic area (NKEA) in considering the contribution towards the national
economics (PEMANDU, 2010). Eight entry point projects (EPP) had been set comprising of contribution in upstream and downstream segment of oil palm industry.
Figure 1.1: Conceptual framework of Palm Oil Industry Sustainability

Concerns:
1. Social and cultural
2. Land loss and conflicts
3. Productivity; reliance of foreign labor in plantation
4. Occupational safety and health
5. Workers’ right, welfare and labor issues
6. Food vs energy (palm oil used for non-food purposes)

Legal and Regulatory Framework

People (Social)

Palm Oil Sustainability

Planet (Environment)

Profits (Economics)

Process Sustainability

Product Sustainability

Key issues highlighted:
1. Oil palm plantation vs. rainforest (deforestation)
2. Ecological balance & biodiversity
3. Wildlife extinction
4. Climate change (green house gases)
5. Air and water pollution
6. Soil erosion and degradation

Challenges ahead:
1. Yield gaps (attributed by farm management, productivities, technologies, R&D, etc)
2. Declining prices (competition) vs. rising cost
3. Smallholders vs. large scale plantation companies
4. Investment of palm oil into downstream potential
Figure 1.2: Entire value chain of Malaysia palm oil industry

(Source: PEMANDU, 2010)

Figure 1.3: Portfolio of New Key Economics Area (NKEA) sectors

(Source: PEMANDU, 2010)
Among the EPPs, the 3 EPP outline the strategies to reduce the dependency of foreign labor in the upstream oil palm plantations as in Figure 1.4 as follow:

- **Independent** smallholders will not be allowed to keep palms tree aged > 25 years that yield 10 tonne/hectares for the past 3 years
- **Organized** smallholders will not be allowed to keep palms tree aged > 25 years that yield 13 tonne/hectares for the past 3 years
- Plantation to limit a maximum of 5% of total plantation land with palms older than 25 years yield < 16 tonnes/hectares for the past 3 years

- Recruiting 493 TUNAS officers in ensuring better extension to independent smallholders
- Clustering all 161,000 independent smallholders around the nearest mill as organized cooperative
- Mandating use of industry best practice in all 3 group of oil palm planters
- Implementing ranking system for cooperative and smallholders

- Scaling up production Cantas™ a motorized harvesting pole
- Promoting use of diamond sharpening tool
- Switching to buffalo assisted in collecting FFB

**Figure 1.4: Entry point projects to scaling up production of oil palm plantation**

(Source: PEMANDU, 2010)
1.2 Problem Statement

The sustainability of oil palm industry has been consistently challenged in the international arena. Various issues, particularly the environmental and social aspect of the oil palm cultivation has become the central focus of debates ranging from destruction of the forest and pollution to animal rights, natives land loss, welfare, etc.

It appear that while the socio-economics advantage and environmental impact were being appropriately addressed by the stakeholders, there has been lack of published data on any surveillance information, current status, experimental or intervention study with respect to safety, health and ergonomics of oil palm plantation.

For example, research application of biotechnology for better thriving and resistance seeds, crossbreeding and/or engineering technological innovation aids such as harvester, fertilizers, pesticides etc (Mohd. Anim, 2010) – to increase yield appears to be extensive. However, there were not as many internationally published studies on safety, health and ergonomics among oil palm workers.

A quick and simple search using google scholar search engine (keywords: ergonomics occupational safety and health Malaysia agriculture) only manage to find three related articles; a review of overturning accidents and safety involving farm tractors by Abubakar et al. (2010), an ergonomics study among rubber tappers by Shan et al. (2011) and a study of energy expenditure among rice cultivation workers by Nawi et al. (2011).

Thus, from the existing literature, there is insufficient knowledge of the harvesting tasks in oil palm plantation despite the values and investment in the industry. Moreover, although high prevalence of MSDs was reported by Nizam and Rampal (2005), Hendra and Rahardjo (2008) as well as Henry et al. (2013), studies which describe the awareness of workers were not found.

From the perspective of productivity, the three entry point projects (EPP) outlined specifically for upstream oil palm plantation by the Malaysia Economic Planning Unit (2010) in the Economic Transformation Programme (ETP) has also failed to recognize the potential of safety, health and ergonomics in reducing losses in terms of productivity despite abundance of studies showing productivity loss due to neglected Occupational, Safety, Health and Ergonomics.

Predominantly, musculoskeletal disorders (MSDs) were being reported as the single most prevalent injuries among agricultural workers (Fathallah, 2010; Chapman and Meyers, 2001), although respiratory disease, noise induced hearing loss, pesticide-related illnesses, and cancers were also among the concerned (Nelson et al., 2005; Miyakita and Ueda, 1997; Alavanja; 2003; Calvert et al., 2008; Von Essen and Banks, 2009; Linaker and Smedley, 2002; Fuhs, 2008).
Publications of articles in various journals (Aronsson et al., 2000; Hagberg et al., 2002; Pelletier et al., 2004; Boles et al., 2004; Burton et al., 2006; Ricci et al., 2007; Alavinia et al., 2009) has found significant productivity losses in their studies particularly in terms of loss of work time which can be expressed in absenteeism as well as presenteeism.

It was estimated that on year 2010, there are approximately 400,000 oil palm harvesters in Malaysia to cover more than 4 million hectares of land planted with oil palm trees (Abdullah et al., 2010). Based on Abdullah et al. (2010), the land to labour ratio indicates labour shortage which was also been consistently reported by Adnan (2010) affecting the upstream production yield.

In terms of the gaps in knowledge, there was also lack of fundamental studies which describes the biomechanical actions of tasks performed by oil palm harvesters from the aspect of ergonomics as well as the risk factors associated with the development of musculoskeletal disorders. Without these knowledge, appropriate intervention or effective control cannot be applied where resources may be wasted on factors which were non-essential.

Besides that, from the various types and categories of intervention approach, socio-demographic background of agricultural workers particularly education level were among challenges and difficulties in ensuring the success of the intervention implemented (Belay and Abebaw, 2004). In Malaysia, although agricultural extension officers and courses exist in Malaysia, there seems to be lack of reporting or publication associated with the success of any such intervention.

It is noteworthy that an integrated intervention approach known as participatory action-oriented training (PAOT) approach has recently been highly promoted by International Labour Organization (ILO). This following the effectiveness demonstrated in developed and various developing countries (Kogi, 2006a; 2006b; 2007; 2008; 2012a; 2012b; Kawakami, et al., 2009) such as Japan, Vietnam, Thailand, Myanmar, Indonesia, etc.

Nevertheless, such approach in Malaysia has yet to be delved or if it has been tested, were not reported or published despite its potential to resolve the ergonomics, safety and health issues in workplace.
1.3 Study Justification

Malaysia palm oil industry is one of the national primary economics’ contributors that span the entire value chain from plantations to downstream activities recording a high export volume of RM59.77 billion worth in revenue for 2010. It is estimated that more than half of a million workers are engaged in the upstream plantation sectors alone in the year 2010 (Abdullah et al., 2011).

Taking into account Occupational Safety and Health as a component in the sustainability framework (Figure 1.1), further investigation particularly of the upstream oil palm plantation sectors is required. This considering researches worldwide has consistently highlighted agricultural sectors as among the most hazardous industry with musculoskeletal disorders the most prevalent and costly of all work-related injuries (Rainbird and O’Neill, 1995; Mazza et al., 1997; Sesto, 2000; Chapman and Meyers, 2001; Davis and Kotowski, 2007).

The significance of this study is to provide an ergonomics insight to harvesting activities in oil palm plantation. The result from this research will reveal current scenario of safety and health cultures, awareness, and practices in Malaysia palm oil sectors including health impacts arises from work task. The primary findings of the existing hazards and exposure of oil palm plantation harvesters will further aid management of these risks in the field.

Proactive measures for controlling these risks can hence be planned the future to reduce exposure or risks level through necessary workplace improvements for the stakeholders. As such, this research will provide a platform for inculcating safety and health awareness through intervention program. It is expected that workplace improvement in terms of costs, productivities increase, knowledge, attitude, and practices will be achieved from reduced prevalence of MSD.

Following that, the critical success and failure factors can then be analyzed for a more comprehensively improved intervention program to be implemented for other similar oil palm plantations in the future. This will in turn benefit many stakeholders in the country especially by the government agencies in the planning and review of policy, guidelines, standards and practices.

Furthermore, it may be worthwhile to test the flexibility of PAOT approach which concept was simple, low-cost focusing on locally available good examples. Being practical, the improvement may be better accepted or applied on workers of lower socio-economics and communication difficulties. This further advantages the target group of this study; foreign labors, which were particularly hired by large profit-oriented multinational companies in Malaysia.
1.4 Objectives

1.4.1 General Objective

To determine the effectiveness of integrated ergonomics interventions approach in resolving ergonomics issues of harvesters and improve workplace during early harvesting stage in oil palm plantation in Johor, Malaysia.

1.4.2 Specific Objective

The specific objectives of this research are to:

i. Identify existing ergonomics risk factors of the work tasks performed by harvesters in oil palm plantations.

ii. Determine the prevalence of musculoskeletal disorders among harvesters in oil palm plantation.

iii. Determine the severity of awkward posture adopted during harvesting work tasks in oil palm plantations.

iv. Determine the loss of productivities (in terms of sick leave – absenteeism, presenteeism, daily harvest quantity and efficiency score) among oil palm harvesters.

v. Determine the association between productivities with the prevalence of musculoskeletal disorders among harvesters in oil palm plantation located at the state of Johor, Malaysia.

vi. Determine the association between the potential risk factors with prevalence of musculoskeletal disorders among harvesters in oil palm plantation located at the state of Johor, Malaysia.

vii. Determine the effectiveness of Participatory Action Oriented Approach intervention program between pre- and post-intervention among the intervention and control group to compare:

a. the knowledge, attitude and practices of ergonomics among harvesters in oil palm plantation located at the state of Johor, Malaysia.

b. the prevalence of musculoskeletal disorders complaints among harvesters in oil palm plantation located at the state of Johor, Malaysia.
1.5 Hypothesis

i. There is significant association between the prevalence of musculoskeletal disorders with productivities among harvesters in oil palm plantation.

ii. There is significant association between the prevalence of musculoskeletal disorders and risk factors among harvesters in oil palm plantation.

iii. The PAOT intervention significantly increases knowledge, attitude and practices score from pre- to post-intervention among intervention and control group.

iv. The PAOT intervention significantly decreases musculoskeletal disorders symptoms from pre- to post-intervention among intervention and control group.
1.6 Conceptual Framework

The conceptual framework (Figure 1.5) in this research is divided into two phases; Phase 1 describes the inter-relationship of dependent and independent variables while Phase 2 describes the concept of intervention approach. In this framework, harvesters interact with their tools as well as their working environment in a complex network of relationship.

This relationship derives the multitude of risk factors, which can be further divided into two major risk factors; the occupational risk factor and individual risk factors (Sanders, 2004; Karwowski and Marras, 1999). Individual risk factors can be further categorized into non-modifiable and modifiable individual risk factors. The occupational risk factors can be classified into ergonomics risk factors and exposure level based on the work environment and job demand at the workplace (Wahlstedt et al., 2010; David, 2005; Devereux, Buckle and Vlachonikolis, 1999).

The risk factors can co-exist in various combination based on different harvesting tools used (i.e.: chisel or sickle, motorized FFB collector or manual wheelbarrow) as well as different working environment (early harvesting stage, mid harvesting stage or late harvesting stage). These are among the primary variables potentially attributes to the development of musculoskeletal disorders (Greene, Goggins and Peterson, 2008; Sanders, 2004; Karwowski and Marras, 1999).

For instance, mechanically aided harvesters may have different risk factors as compared to harvesters using intensive manual labour. Concurrently differences may also be amplified by management of the plantation which practice different work system or work organization. Further differences can also characterized by the individual risk factors are non-modifiable risk factors such as age, gender, ethnicity, medical history and biodynamic response are among the variables that has been associated with work-related MSDs.

Another major non-modifiable risk factor is previous medical history. Past injuries or diseases such as fractures, tendon or ligament injuries from sports or arthritis may further increase risk of musculoskeletal disorders or aggravate existing MSDs (Sanders, 2004). Although the injuries or fractures may heal over time, alteration or exhaustion of the body sites may increase the susceptibility of developing musculoskeletal disorders.

On the other hand, the modifiable risk factors such as increased body mass index (BMI), smoking status, hobbies or sports activities and household chores or responsibilities has also been positively associated with MSDs. These adjustable factors if being modified or intervened towards a healthier lifestyle will reduce the risk of developing musculoskeletal disorders to a certain extent although excessive sports activities can be detrimental to some extent (Tsuboi et al., 2002).

While it has been shown in various epidemiological studies that exposure to occupational psychosocial and ergonomics risk factors (Karwowski and Marras, 1999); such as
awkward posture, forceful exertion, static loading, contact stress, vibration, repetitive motion and extreme environment as well as can cause MSDs, most workplace expose workers to a combination of two or more of these risk factors (Greene, Goggins and Peterson, 2008).

Exposure to the ergonomics risk factors are also highly dependent upon the level of exposure such as working history, frequency and duration of exposure as well as work organization (Marras and Karwowski, 2006). In particular, previous employment is an important consideration with regards to onset of development where past exposure may have been underlying cause and further aggravated by current work practices.

Conceptually, there are 4 types of intervention (Figure 1.6) targeted to reduce the overall musculoskeletal disorders of harvesters. Participatory Action Oriented Training program is an administrative design intervention developed to directly modify job or task, potentially through engineering improvement while increasing awareness.

It is expected that the increase of awareness may facilitate change of attitude and behavior. These changes including engineering improvement were ultimately targeted to reduce the ergonomics risk factors and the level of exposure as well as modifiable individual risk factors (Sanders, 2004; Marras and Karwowski, 2006).

An example of engineering approach is the use of tools which are ergonomically designed to modify the risk factors. Compared to traditional work method or existing tool used, tools engineering approach target to alter the postural and force demand in reducing the risk of musculoskeletal disorders.

Alternatively, administrative strategy re-design workplace or work pace to allow longer rest or recovery period which is ergonomically sound and acceptable to the workers. Likewise, increase of awareness can be achieved through seminars, workshops or hands-on practical which target was to modify risk factors through increase of knowledge hence attitude, behavior and practices.

Integrating the hierarchy of controls, PAOT was designed to concurrently consider all approach which can be potentially applied at workplaces. The intervention is facilitated through a participative training session which focus highly on the use of a modified action checklist. The suggested intervention should originate from participants – usually the workers as they understand their workplace best.

The action checklist (ILO, 2010; 2012) is a concept based on local good practices which is low cost and simple to reduce the prevalence of intended health effect designed against it while increasing workplace safety, health and productivity (Kogi, 2006a; 2006b; 2007; 2008; 2012a; 2012b; Kawakami, 2009).
Figure 1.5: Conceptual Framework of Phase 1 Research

Legend
- Independent variables
- Dependent variables
- Studied variable
- Objectives/Paper

Phase 1

Specific Objective 6 (Paper 4)

Specific Objective 4 and 5 (Paper 3)

Specific Objective 2 and 3 (Paper 2)

Harvesters

Individual risk factors

Non-Modifiable
- Age
- Gender
- Past medical history
- Ethnicity
- Biodynamic response

Specific Objective 1 (Paper 1)

Modifiable
- Body mass index
- Sport/outdoor activities
- Smoking status
- Household chores

Work-related musculoskeletal disorders (MSDs)
- Productivity loss
  - Quantity
  - Quantity
  - Presenteeism
  - Absenteeism

Exposure
- Work duration
- Frequency & duration of rest
- Years of employment
- History of employment

Ergonomics
- Contact stress
- Extreme environment
- Repetitive action
- Static loading
- Forceful exertion
- Awkward posture

Observation
- Organization
- Plantation
- Height
- Land contour/terrain

Work environment

Tools/equipment

Waldstedt et al., 2010; David, 2005; Deveraux, Buckle & Vlachonikolis, 1999

Greene, Goggins & Peterson, 2008

Greene, Goggins & Peterson, 2008; Sanders, 2004; Karwowski & Marras, 1999

Arosson et al., 2000; Hagberg et al., 2002; Pelletier et al., 2004; Boles et al., 2004; Burton et al., 2006; Ricci et al., 2006; Alaviania et al., 2009
Figure 1.6: Conceptual Framework of Phase 2 Research
1.7 Conceptual and Operational Definitions

1.7.1 Musculoskeletal disorders

i) Conceptual Definition

By focusing the musculoskeletal anatomical counterpart of the disorders being address, MSDs can be defined as an umbrella term of the disorders or diseases affecting soft tissues of the body such as the muscles, tendons, ligaments, peripheral nerves, joints, cartilage, bones and/or supporting vessels which exclude acute or instantaneous attribution (US Department of Labour, 2012; Herrick and Dement, 2005).

ii) Operational Definition

The self-reported symptomatic complaints of pain, aches or discomfort on any of the body region; neck, shoulder, elbow, hand/arms, upperback, lowerback, one or both thigh(s), one or both knee(s), one or both ankle(s) at any time over the past 12 months and 7 days as obtained by modified NORDIC Musculoskeletal Questionnaires (NMQ) (Kuorinka et al., 1987) in this research.

1.7.2 Ergonomics risk factors

i) Conceptual Definition

Ergonomics risk factors are the aspects of a job or task, behavior or work condition or situation that has been demonstrated through research which increases the risk of developing musculoskeletal disorders through biomechanical stress imposed on a worker such as awkward posture, forceful exertion, static loading, contact stress, vibration, repetitive motion, extreme environment (temperature, lighting, and noise), etc.

ii) Operational Definition

Ergonomics risk factors were the collective risks of developing musculoskeletal disorders based on the conceptual definition which were qualitatively identified during site visit and further observed through video recording. Specifically, awkward posture were quantitatively evaluated using Ovako Working Posture Assessment System (OWAS) (Karhu et al., 1977) for each harvesters based on postures adopted during harvesting tasks observed from their videos recorded.
1.7.3 Productivity

i) Conceptual Definition

The term productivity since first coined by Quesnay (1768) in the *Journal de l’Agriculture* has been defined and used widely by various people and organization. As Tangen (2005) and Mangat (2010) described, the multidimensional use of the term are dependent upon context within which it was used.

Nevertheless, based on an extensive review, productivity can be defined as “the ratio of what is produced to what is required to produce it” (Preece, 1983). This was concurrently the definition adopted by ILO (SAFEWORK, 2006), the Third Agenda of Global Employment Agenda discussing contribution of OSH in improving productivity.

In this study, productivity loss can be conceptually defined as the reduction of productivity due to unanticipated conditions – in this case health-related, injuries or illnesses. In layman term, loss of productivity is thus the differences of productivity which is actually observed and that of might have been expected without the unanticipated conditions – ideal situation.

ii) Operational Definition

Productivities of the workers are expressed as losses in this study where the four different dimensions were as described in Table 1.1.
Table 1.1: Operational definition of productivity expressed in four derivatives

<table>
<thead>
<tr>
<th>Productivity</th>
<th>Operational definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daily weight of FFB harvested</td>
<td>The weight of daily harvest for each pair of harvested as recorded by the plantation management</td>
</tr>
<tr>
<td>Sick leave</td>
<td>Self-reported absence of harvesters from work due to pain or disorders of the musculoskeletal system</td>
</tr>
<tr>
<td>Presenteeism</td>
<td>Self-reported attendance to work despite experiencing pain or disorders of the musculoskeletal system</td>
</tr>
<tr>
<td>Efficiency</td>
<td>A 10-point quantity and quality numerical rating scale which are rated by harvesters of the work performed during presenteeism.</td>
</tr>
</tbody>
</table>
1.7.4 Knowledge, Attitude and Practices

i) Conceptual Definition

Knowledge in terms of health refers to a set of understanding and of science. The degree or the body of knowledge commonly acquired either via formal education and informal education provides one’s capacity for imagining or perceiving which translates into attitude and practices in the domain of health (Gumucio et al., 2011).

Practice or sometimes used inter-exchangeable with behavior is an observable actions of individual. Although it is common to attribute actions as a response to the specific health event as a result of the knowledge acquired, it is however not always the case as the individual may subjectively act contrastingly (Gumucio et al., 2011).

On the other hand, attitude explains the subjective idea or perception which exists between the state of knowledge and practice response to the environment as a way of being or position towards the event. Attitude is not an observable intermediate variable but may help explain among the possible practices when the individual is subjected to stimulus (Gumucio et al., 2011).

Hogg and Vaughan (2005) on the other hand describe attitude as tendencies in terms of beliefs, feelings and behavioral towards objects, events, groups or symbols while Eagly and Chaiken (1993) define attitude as psychological tendency of expression or evaluation with certain degree of favor or disfavor towards a particular entity.

ii) Operational Definition

Current and post-intervention knowledge, attitude and practices of harvesters on Occupational Safety, Health and Ergonomics (OSHE) related to their work tasks were measured using a set of self-administered questionnaire. Respondents’ score of knowledge, attitude and practices are calculated and classified respectively which will be further described in Chapter 3.
CHAPTER SUMMARY

This chapter has provided a brief introduction to the background of oil palm and the problem faced by the oil palm plantation. The importance of this research has also been justified, where the objectives and the corresponding hypothesis of this study were being specified. The conceptual framework of this research has been presented whereas the key terminology used in this research has also been defined conceptually and operationally.
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